

CLAIMS

1. A driver comprising:

a voltage-follower-type operational
5 amplifier for receiving current input data to generate an output signal;

a transient state detecting circuit for
detecting a transient state in said current input data to
generate a first pulse signal when said current input data is
10 increased and generate a second pulse signal when said current input data is decreased; and

a switch circuit, connected between said
transient state detecting circuit and said
voltage-follower-type operational amplifier, for
15 substantially increasing corresponding load currents flowing through said voltage-follower-type operational amplifier in accordance with said first and second pulse signals.

2. The driver as set forth in claim 1, wherein said transient state detecting circuit comprises:

20 a data register circuit for storing a previous input data of said current input data;

a comparator, connected to said data register circuit, for comparing said current input data with said previous input data;

25 a first pulse signal generating circuit, connected to said comparator, for generating said first pulse signal when said current input data becomes larger than said previous input data; and

a second pulse signal generating circuit,
30 connected to said comparator, for generating said second pulse signal when said current input data becomes smaller than said previous input data.

3. The driver as set forth in claim 2, wherein said

first pulse generating circuit comprises a one-shot triggered by a rising edge of an output signal of said comparator, and said second pulse generating circuit comprises a one-shot triggered by a falling edge of the output signal of said
5 comparator.

4. The driver as set forth in claim 2, wherein said switch circuit comprises:

a first switch, connected to said first pulse generating circuit and being turned ON by said first pulse
10 signal; and

a second switch, connected to said second pulse generating circuit and being turned ON by said second pulse signal.

5. The driver as set forth in claim 4, wherein each of
15 said first and second switches comprises a MOS transistor.

6. The driver as set forth in claim 4, wherein each of said first and second switches comprises a bipolar transistor.

7. The driver as set forth in claim 1, wherein said voltage-follower-type operational amplifier comprises:

20 first and second power supply lines;
first and second current sources connected to said second and first power supply lines, respectively;
a first differential pair of a first conductivity type, connected to said first current source, for
25 differentially amplifying said current input data and said output signal;

a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said
30 current input data;

a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said

first differential pair and an output connected to a non-inverting output of said second differential pair;

5 a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

10 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

15 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

load currents flowing through said third current mirror circuit substantially increasing in accordance with said first and second pulse signals.

20 8. The driver as set forth in claim 4, wherein said voltage-follower-type operational amplifier comprises:

first and second power supply lines;

first and second current sources connected to said second and first power supply lines, respectively;

25 a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said output signal;

30 a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

a first current mirror circuit of said second

conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

5 a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

10 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

15 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

20 said first switch being connected between said first power supply line and the output of said first current mirror circuit,

 said second switch being connected between said first power supply line and the output of said second current mirror circuit.

25 9. The driver as set forth in claim 4, wherein said voltage-follower-type operational amplifier comprises:

 first and second power supply lines;

 first and second current sources connected to said second and first power supply lines, respectively;

30 a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said output signal;

a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

5 a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

10 a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

15 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

20 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

25 said first switch being connected between said second power supply line and the output of said third current mirror circuit,

said second switch being connected between said first power supply line and the output of said second current mirror circuit.

30 10. The driver as set forth in claim 4, wherein said voltage-follower-type operational amplifier comprises:

first and second power supply lines;

first and second current sources connected to

said second and first power supply lines, respectively;

a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said output signal;

a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

said first switch being connected between said second power supply line and the output of said third current mirror circuit,

said second switch being connected between said second power supply line and the input of said third

current mirror circuit.

11. The driver as set forth in claim 4, wherein said voltage-follower-type operational amplifier comprises:

first and second power supply lines;

5 first and second current sources connected to said second and first power supply lines, respectively;

a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said
10 output signal;

a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

15 a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

20 a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

25 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

30 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

said first switch being connected between said first power supply line and the output of said first current mirror circuit,

5 said second switch being connected between said second power supply line and the input of said third current mirror circuit.

12. A data line driver circuit for driving a plurality of data lines in a display apparatus comprising:

10 a shift register circuit for generating latch signals;

a plurality of data register circuits, connected to said shift register circuit, each for latching current input data in synchronization with a respective one of said latch signals;

15 a plurality of digital/analog converters, each connected to one of said data register circuits, for performing digital/analog conversions upon said current input data; and

20 a plurality of drivers for receiving analog output voltages from said digital/analog converters to generate output signals for said data lines,

each of said drivers comprising:

25 a voltage-follower-type operational amplifier, connected to one of said digital/analog converters, for receiving one of said analog output voltages to generate one of said output signals;

30 a transient state detecting circuit, connected to said shift register circuit and one of said data register circuits for detecting a transient state in a respective one of said current input data to generate a first pulse signal when the respective one of said current input data is increased and generate a second pulse signal when the respective one of said current input data is decreased; and

a switch circuit, connected between said transient state detecting circuit and said voltage-follower-type operational amplifier, for substantially increasing corresponding load currents flowing through said voltage-follower-type operational amplifier in accordance with said first and second pulse signals.

13. The data line driver circuit as set forth in claim 12, wherein said transient state detecting circuit comprises:

an additional data register circuit,
connected to a respective one of said data register circuit, for latching a previous input data of the respective one of said current input data in synchronization with a respective one of said latch;

a comparator, connected to the respective one of said data register circuit and said additional data register circuit, for comparing said current input data with said previous input data;

a first pulse signal generating circuit, connected to said comparator, for generating said first pulse signal when said current input data becomes larger than said previous input data; and

a second pulse signal generating circuit, connected to said comparator, for generating said second pulse signal when said current input data becomes smaller than said previous input data.

14. The data line driver circuit as set forth in claim 13, wherein said first pulse generating circuit comprises a one-shot triggered by a rising edge of an output signal of said comparator, and said second pulse generating circuit comprises a one-shot triggered by a falling edge of the output signal of said comparator.

15. The data line driver circuit as set forth in claim 13, wherein said switch circuit comprises:

a first switch, connected to said first pulse generating circuit and being turned ON by said first pulse signal; and

5 a second switch, connected to said second pulse generating circuit and being turned ON by said second pulse signal.

16. The data line driver circuit as set forth in claim 15, wherein each of said first and second switches comprises a MOS transistor.

10 17. The data line driver circuit as set forth in claim 15, wherein each of said first and second switches comprises a bipolar transistor.

15 18. The data line driver circuit as set forth in claim 15, wherein said voltage-follower-type operational amplifier comprises:

first and second power supply lines;

first and second current sources connected to said second and first power supply lines, respectively;

20 a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said output signal;

25 a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

30 a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

a second current mirror circuit of said second conductivity type connected to said first power supply line

and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

5 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

10 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

load currents flowing through said third current mirror circuit substantially increasing in accordance with said first and second pulse signals.

15 19. The data line driver circuit as set forth in claim 15, wherein said voltage-follower-type operational amplifier comprises:

20 first and second power supply lines;
first and second current sources connected to said second and first power supply lines, respectively;

a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said output signal;

25 a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

30 a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a

non-inverting output of said second differential pair;

a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

said first switch being connected between said first power supply line and the output of said first current mirror circuit,

said second switch being connected between said first power supply line and the output of said second current mirror circuit.

20. The data line driver circuit as set forth in claim 15, wherein said voltage-follower-type operational amplifier comprises:

first and second power supply lines;
first and second current sources connected to said second and first power supply lines, respectively;

a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said output signal;

a second differential pair of a second conductivity type, connected to said second current source,

for differentially amplifying said output signal and said current input data;

5 a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

10 a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

15 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

20 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

said first switch being connected between said second power supply line and the output of said third current mirror circuit,

25 said second switch being connected between said first power supply line and the output of said second current mirror circuit.

30 21. The data line driver circuit as set forth in claim 15, wherein said voltage-follower-type operational amplifier comprises:

first and second power supply lines;

first and second current sources connected to said second and first power supply lines, respectively;

a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said output signal;

5 a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

10 a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

15 a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

20 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

25 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

30 said first switch being connected between said second power supply line and the output of said third current mirror circuit,

said second switch being connected between said second power supply line and the input of said third current mirror circuit.

22. The data line driver circuit as set forth in claim 15, wherein said voltage-follower-type operational amplifier comprises:

first and second power supply lines;

5 first and second current sources connected to said second and first power supply lines, respectively;

a first differential pair of a first conductivity type, connected to said first current source, for differentially amplifying said current input data and said
10 output signal;

a second differential pair of a second conductivity type, connected to said second current source, for differentially amplifying said output signal and said current input data;

15 a first current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to an inverting-output of said first differential pair and an output connected to a non-inverting output of said second differential pair;

20 a second current mirror circuit of said second conductivity type connected to said first power supply line and having an input connected to a non-inverting-output of said first differential pair and an output connected to an inverting output of said second differential pair;

25 a third current mirror circuit of said first conductivity type connected to said second power supply line and having an input connected to a non-inverting-output of said second differential pair and an output connected to an inverting output of said second differential pair; and

30 a single-end push-pull circuit, connected between said first and second power supply lines, for receiving a voltage at the output of said third current mirror circuit to generate said output signal,

said first switch being connected between said first power supply line and the output of said first current mirror circuit,

5 said second switch being connected between
said second power supply line and the input of said third
current mirror circuit.